

**FINAL SUMMARY REPORT**

**GEOPHYSICAL INVESTIGATION  
OF THE  
SUSPECTED DRUM BURIAL AREA**

**Camp Bonneville  
Vancouver, Washington**

*Prepared for:*

**U.S. Army Corps of Engineers  
Huntsville Center  
Mandatory Center of Expertise & Design Center  
Ordnance and Explosive Waste**

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*Presented by*

**PARSONS ENGINEERING SCIENCE, INC.**

**Atlanta, Georgia**

*August 2001*



**PARSONS**

**FINAL  
SUMMARY REPORT  
GEOPHYSICAL INVESTIGATION OF CAMP BONNEVILLE  
SUSPECTED DRUM BURIAL SITE**

## **1.0 PURPOSE AND SCOPE**

1.1 Parsons Engineering Science, Inc. (Parsons ES) conducted a geophysical survey of a suspected drum burial site within former Camp Bonneville, Vancouver, Washington. This work was performed for the U.S. Army Engineering and Support Center, Huntsville (USAESCH) and the U.S. Army Corp. of Engineers, Seattle District (CENWS).

1.2 The purpose of this report is to present the findings of the geophysical survey that was performed at the suspected drum burial area at Camp Bonneville in October 2000. This report presents a brief summary of the history of Camp Bonneville, the field activities conducted under this geophysical survey, and the results of the geophysical investigation. The activities conducted at the suspected drum burial area to date included site preparation, location surveys and geophysical surveys. Actual confirmation of the content or identification of the anomalies found on this site has not been conducted.

## **2.0 BACKGROUND**

2.1 Camp Bonneville is a 3,839-acre site located in southwestern Washington State that has been used by the Department of the Army and others for training for approximately 85 years. Camp Bonneville lies in Clark County, approximately 10 miles northeast of Vancouver, Washington, in the Cascade Mountains. Large rural residential developments, densely forested lands, and small farms bound the property on all sides.

2.2 The suspected drum burial site is in the Lacamas Creek valley in the western portion of former Camp Bonneville near the cantonment area. The site was relatively flat and was bounded on the west by a road and on the east by the meandering Lacamas Creek. Figure 1 is a map showing the location of the suspected drum burial area relative to the Camp Bonneville boundaries.

2.3 The results of a previous geophysical survey with a Geonics EM31 terrain conductivity meter indicated that this area may be suspect for disposal of paint solvents and possible drums. For this reason, an area covering approximately 8 acres was chosen for additional geophysical survey including a re-survey of the area identified in the EM31 survey.

### 3.0 SITE PREPARATION

3.1 Site preparation consisted of clearing the site of brush, scanning the site for surface OE and surface scrap, and establishing a reference grid for the geophysical surveys. The existing vegetation in the 8-acre area made it necessary for clearing using a brush hog and hydro-axe. During the brush clearing process, Parsons UXO escorts scanned the surface of the site for possible hazards due to OE and other scrap.

3.2 A reference grid consisting of 100-ft by 100-ft cells was established by a registered surveyor (Hagedorn Inc.). The grid corners were staked with wooden stakes and recorded at even increments in Washington State Plane coordinates. Due to the heavy vegetation on the northern and eastern portions of the 8-acres and the gravel road along the southern and western boundary, some of the grids were shortened or modified.

### 4.0 GEOPHYSICAL SURVEY

4.1 Given that the objective of this investigation was to delineate any suspected drum burial areas, a G-858 portable cesium magnetometer/gradiometer was selected for use at the site. Multiple geophysical instruments were tested on a test grid located in similar terrain and geology over various known seeded OE type items. These items were chosen to represent OE items that were expected to be found throughout other areas of Camp Bonneville other than the suspected drum burial area. This test was performed in order to select an instrument to perform geophysical surveys at Camp Bonneville with the purpose being to locate OE items.

4.2 Although the G-858 was out performed by other systems on the test grid, the G-858 was able to detect a portion of these items and has historically performed well for detecting buried drums. In order to produce the detection capability needed to detect the OE type items suspected at Camp Bonneville, the G-858 would have to be supplemented with an electromagnetic instrument. The G-858 was configured as a vertical gradiometer with the sensors separated by 24 inches. Each sensor measures the total magnetic field intensity. The vertical magnetic gradient is computed from the difference between the two total field values.

4.3 The magnetometer surveys were conducted by carrying the G-858 along parallel lines on a grid system. The lines were spaced two feet apart. Data were sampled at a rate of 10 readings per second and were recorded directly by the G-858 console. Fiducial points were inserted into the data stream to denote the crossing of grid lines every 50 feet. A field book was used to record data concerning start and stop points, line numbers, file names and observations.

4.4 Several measures were taken to monitor the quality of the data collected. The response of a standard metal spike was recorded several times per day. Some lines were repeated and tie-lines (perpendicular to the direction of the survey lines) were recorded at

intervals. During collection and processing, the data were checked for completeness and integrity.

4.5 The G-858 data were transferred to a field computer. As part of the data downloading, the vertical magnetic gradient was computed from simultaneous readings of the top and bottom sensors. Diurnal corrections of the total magnetic field intensity reading of the top and bottom channels were made using data collected with a single-sensor magnetic base station.

4.6 The processing consisted of adjusting the spacing of points along lines and translation of the data to Washington State plane coordinates. The data were then viewed and interpreted for anomalies by a Parsons geophysicist. Because one of the sensors on the G-858 generated occasional noise spikes, additional editing and filtering was needed. A three-point non-linear filter was used on some of the bottom sensor data. The data were also leveled to produce the plots. The data for top and bottom sensors are shown as color level plots in Figures 2 and 3.

## 5.0 RESULTS OF SURVEY

5.1 The results of the geophysical data processing and interpretation are presented on Figures 2 and 3. Anomalies having sufficient areal extent and strength to be interpreted as being possible drum burials have been identified. The anomalies are labeled A through K and marked by red or black rectangles. The South Area (Figure 2) had four anomalies (A through D) that could be attributed to one or two drums. In the North Area (Figure 3), Anomalies E, F, H, I, and J were large enough to be one or two drums. Anomaly G, associated with a drum exposed at the surface, could be generated by a dozen or more drums. Anomaly K, just west of Anomaly G, covers a smaller area and has lower amplitude, possibly indicating deeper burial. Table 1 shows the locations of the centers of the anomalies and the values of the total magnetic field intensity at the top sensor.

**Table 1: Locations of Anomalies**

ID	Easting (U.S. Survey Feet)	Northing (U.S. Survey Feet)	Anomaly (nT)
A	1148772.14	134994.38	260.7
B	1148832.38	135090.33	809.2
C	1148893.25	135096.39	423.9
D	1148926.71	135114.57	236.9
E	1148393.57	135942.91	640.0
F	1148641.63	135889.41	-85.0
G	1148677.42	135740.53	6568.5
H	1148774.47	135769.34	132.1
I	1148705.70	135668.68	45.8
J	1149113.02	135974.42	-79.1
K	1148634.50	135741.47	-29.2

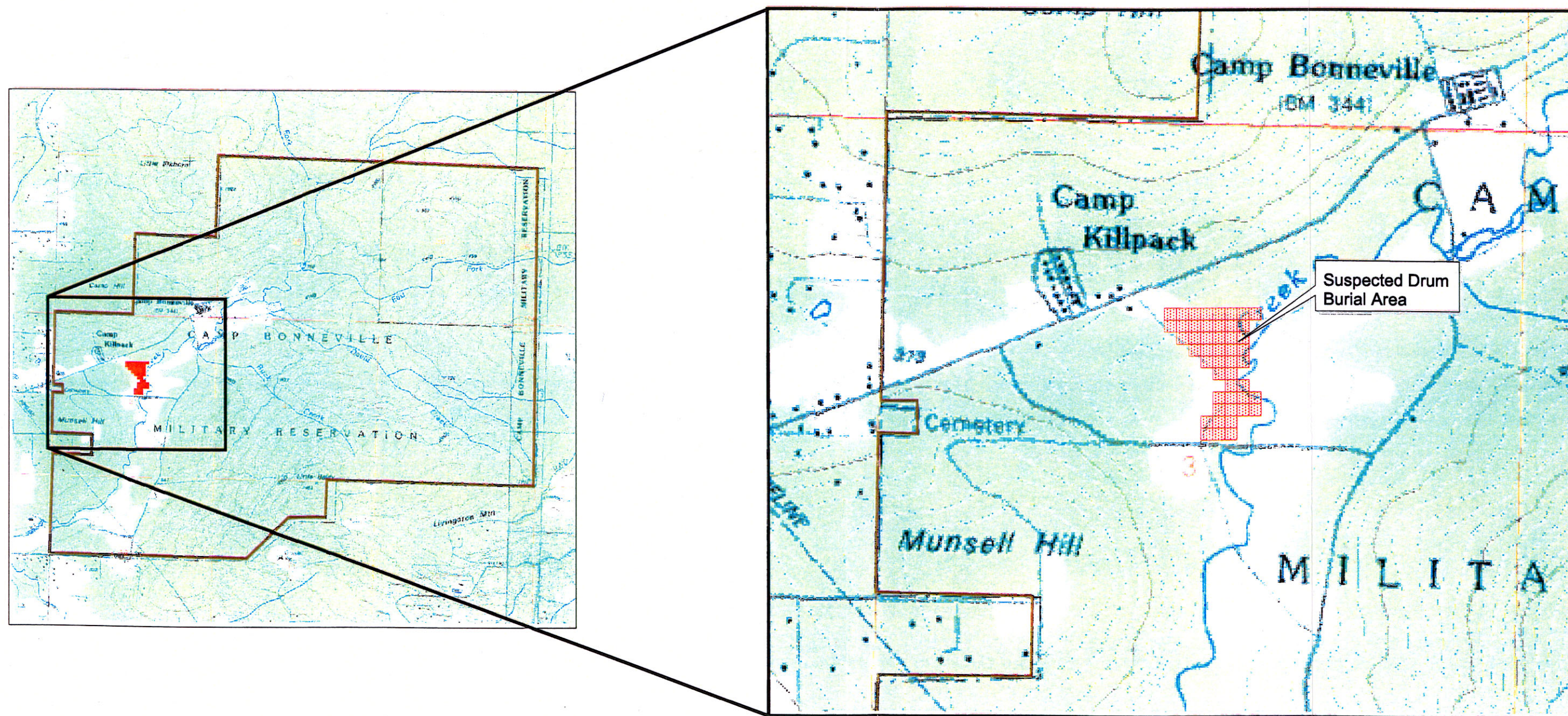
5.2 Several surface items that caused small anomalies were identified by the field teams including wooden pallets near Anomaly F and a trash pile east of Anomaly I. The access road also had a strong magnetic response. It is uncertain whether the strong response is due to the type of rock used to construct the road or if it contains metal. Anomalies were also identified that had signatures typical of items much smaller than buried drums. These anomalies were not selected for further investigation since drum burial sites were the target of this investigation.

5.3 In addition to the metallic anomalies identified, the magnetometer data indicated relatively large variations over broad areas. These variations are likely due to changes in the subsurface geology. The volcanic rocks in the area are known to contain ferromagnetic minerals.

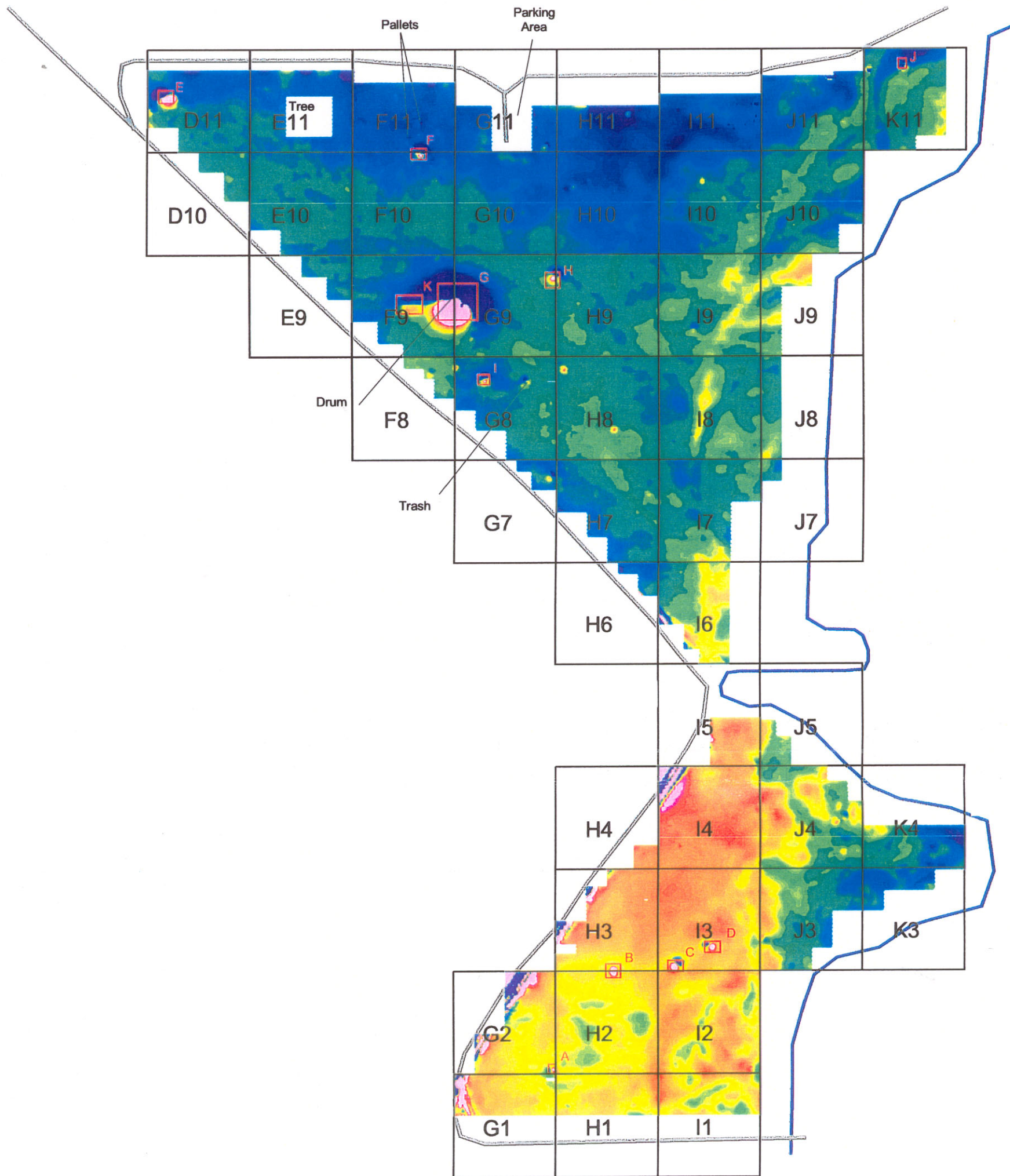


Figure 1

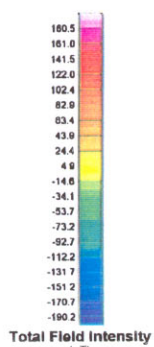
# Camp Bonneville Suspected Drum Burial Area Location










## Legend



Total Field Intensity (mT)

-  Road
-  Creek
-  Anomaly


## Camp Bonneville Vancouver, WA Suspected Drum Burial Site

Geometrics G-858G  
Top Sensor  
2' Line Spacing

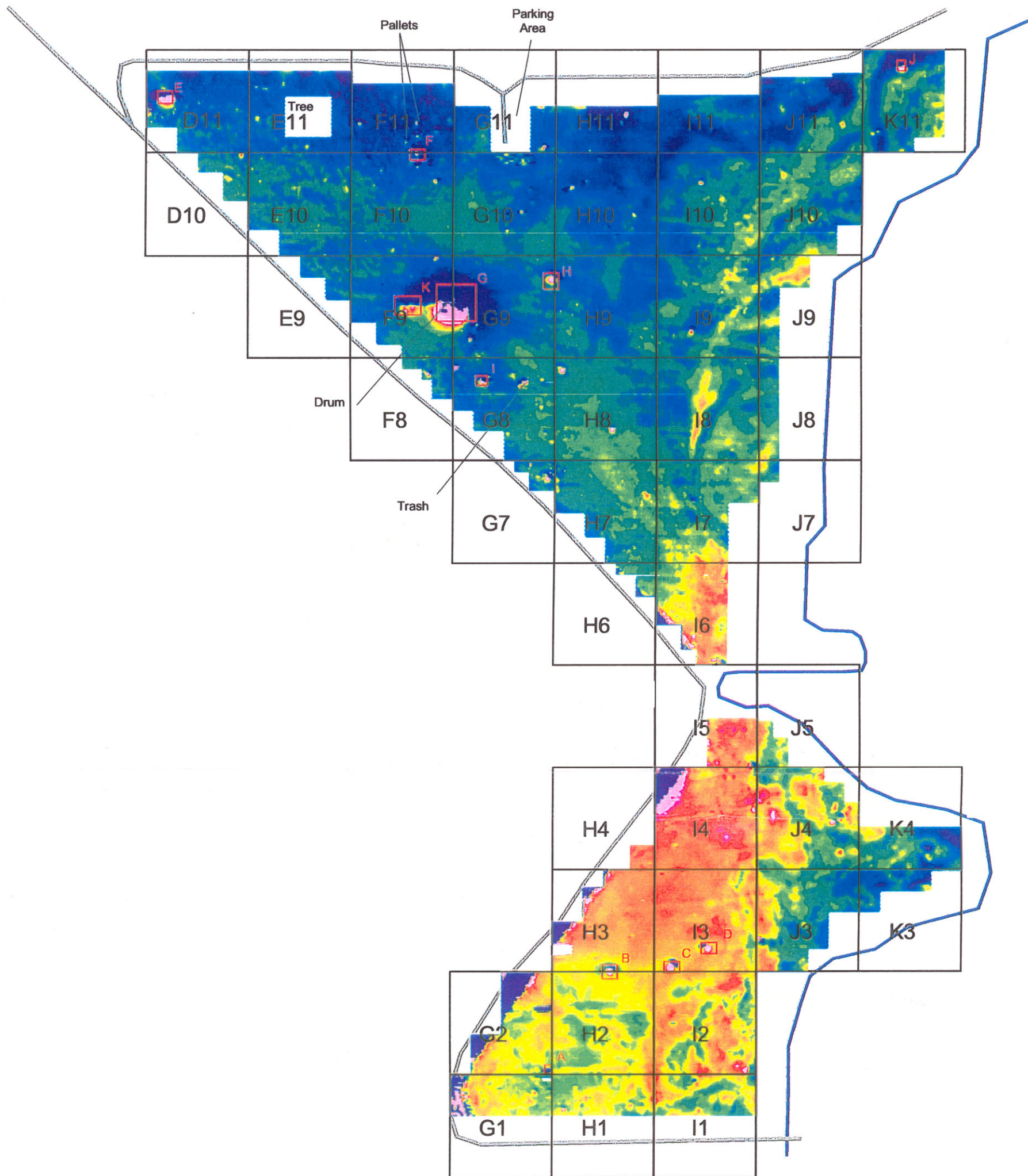


100 0 100 Feet

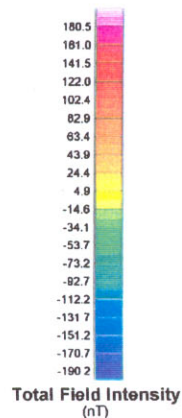
Figure 2




PARSONS ENGINEERING SCIENCE, INC.		U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER	
DESIGNED BY:  Parsons	Camp Bonneville Vancouver, WA		
DRAWN BY:  Parsons			
CHECKED BY:  Parsons	SCALE: 1:1300	PROJECT NUMBER:  734265	
SUBMITTED BY:  Parsons	DATE: November 29, 2000	PAGE NUMBER:  1	
FILE: j:\gis\734265\burial_Bacre			





## Legend



-  Road
-  Creek
-  Anomaly


## Camp Bonneville Vancouver, WA Suspected Drum Burial Site

Geometrics G-858G  
Bottom Sensor - Filtered  
2' Line Spacing



100 0 100 Feet

Figure 3

PARSONS ENGINEERING SCIENCE, INC.		U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE CENTER	
DESIGNED BY: Parsons	Camp Bonneville Vancouver, WA		
DRAWN BY: Parsons			
CHECKED BY: Parsons	SCALE: 1:1300	PROJECT NUMBER: 734265	
SUBMITTED BY: Parsons	DATE: November 29, 2000	PAGE NUMBER: 1	
	FILE: j:\gis\734265\burial_8acre		



## DESIGN REVIEW COMMENTS

PROJECT Control No. 12-029-00 Proj WABONNB1NPS, S: 08 Dec 00

<input checked="" type="checkbox"/> SITE DEV & GEO	<input type="checkbox"/> MECHANICAL	<input type="checkbox"/> SAFETY	<input type="checkbox"/> SYSTEMS ENG	<input type="checkbox"/> DRAFT DRUM BURIAL REPORT
<input type="checkbox"/> ENVIR PROT& UTIL	<input type="checkbox"/> MFG TECHNOLOGY	<input type="checkbox"/> ADV TECH	<input type="checkbox"/> VALUE ENG	<input type="checkbox"/> REVIEW DATE
<input type="checkbox"/> ARCHITECTURAL	<input type="checkbox"/> ELECTRICAL	<input type="checkbox"/> ESTIMATING	<input type="checkbox"/> OTHER	<input type="checkbox"/> NAME
<input type="checkbox"/> STRUCTURAL	<input type="checkbox"/> INST & CONTROLS	<input type="checkbox"/> SPECIFICATIONS		<input type="checkbox"/> ACTION

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.		<p>Is it necessary to refer to the OE portion of the project in this report or can the report be specifically relating to drum burial? There is a statement in this section 4.2, "In order to produce the detection capability needed to detect the OE..." This statement does not directly relate to the drum burial study. If not necessary for this report, it can be removed.</p>	<p>The reference to the OE portion is necessary to explain to the reader that this survey performed by the G-858 alone does not constitute a geophysical survey to find individual OE items and was intended for locating drum burial sites. This is exemplified by the results of the Geophysical Prove-Out.</p>

ACTION CODES  
A - ACCEPTED/CONCUR  
D - ACTION DEFERRED  
W - WITHDRAWN  
N - NON-CONCUR  
VE - VE POTENTIAL/VEP ATTACHED

## DESIGN REVIEW COMMENTS

PROJECT Control No. 12-029-00 Proj WABONNB1NPS, S: 08 Dec 00

<input checked="" type="checkbox"/> SITE DEV & GEO	<input type="checkbox"/> MECHANICAL	<input type="checkbox"/> SAFETY	<input type="checkbox"/> SYSTEMS ENG	REVIEW	Drum Burial Data
<input type="checkbox"/> ENVIR PROT& UTIL	<input type="checkbox"/> MFG TECHNOLOGY	<input type="checkbox"/> ADV TECH	<input type="checkbox"/> VALUE ENG	DATE	08 Dec 00
<input type="checkbox"/> ARCHITECTURAL	<input type="checkbox"/> ELECTRICAL	<input type="checkbox"/> ESTIMATING	<input type="checkbox"/> OTHER	NAME	Debra Edwards/ED-CS-G
<input type="checkbox"/> STRUCTURAL	<input type="checkbox"/> INST & CONTROLS	<input type="checkbox"/> SPECIFICATIONS			

ITEM	DRAWING NO. OR REFERENCE	COMMENT	ACTION
1.		The data and picked targets are acceptable. There are other smaller dipole anomalies in the area. Are these too small to possibly be drums which are deeply buried?	The magnetic anomalies created by buried drums are expected to be at least 10 to 15 feet across or larger depending on the number of drums. As the drums are buried deeper, the anomalies are lower in amplitude but still a large area. At the lowest amplitudes, the area of the anomaly may be difficult to distinguish. High amplitude anomalies with small areas are expected to be caused by smaller metal objects. Of course, this interpretation assumes relatively intact drums.
2.		In the South Area files: Files G1_H1_I1.xyz, G2_H2_i2.xyz, and G3_to_K3 have the appropriate number of columns of data as described in the header lines. Files G4_to_K4.xyz and I5_J5.xyz are missing a column. Please clarify the columns of data for these files.	The files will be regenerated and the headers corrected. Some columns were inadvertently left out.
3.		In the North Area files: The header files describe one extra column of data than is actually present in the data columns. Please clarify.	Some of the files in the north area did not require filtering for spikes. The file headers will be corrected to reflect the data columns.

ACTION CODES                      W - WITHDRAWN  
A - ACCEPTED/CONCUR            N - NON-CONCUR  
D - ACTION DEFERRED            VE - VE POTENTIAL/VEP ATTACHED